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COMPARISON OF THE CRANE FLIES (DIPTERA: TIPULIDAE)
OF TWO WOODLANDS IN EASTERN KANSAS,
WITH A KEY TO THE ADULT CRANE
FLIES OF EASTERN KANSAS¹

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TABLE OF CONTENTS

	PAGE
INTRODUCTION	408
GENERAL FEATURES OF THE STUDY AREAS	408
CRANE FLY HABITATS	409
METHODS	411
SEASONAL DISTRIBUTION	411
RELATIVE ABUNDANCE OF SPECIES	412
ANNOTATED LIST OF SPECIES	412
DISCUSSION	428
LITERATURE CITED	431
APPENDIX—A Key to the Adult Crane Flies of Eastern Kansas	431

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ABSTRACT

Data on geographical and ecological distribution have been compiled for the 95 species of crane flies found in two natural areas in northeastern Kansas, the Breidenthal Reserve and the Natural History Reservation of the University of Kansas. These distributions correlate well with various major plant communities, or with specific habitats. The ranges of several species are extended significantly westward. New records for species not previously recorded within 500 miles of Lawrence, Kansas, include: *Nephrotoma alterna*, *Tipula* (L.) *perlongipes*, *Limonia* (D.) *haeretica*, *Dicranoptycha elsa*, *D. megaphallus*, *D. septemtrionis*, *Gonomyia* (L.) *manca*, *Ormosia arcuata*, *O. ingloria*, *Tasiocera* (D.) *ursina* and *Molophilus pubipennis*.

INTRODUCTION

This paper reports the results of intensive field studies of the crane fly populations of two natural areas belonging to the University of Kansas, the Natural History Reservation and the Breidenthal Reserve. The primary objective was to determine and compare what species comprise the crane fly faunas of the two reservations, and to ascertain their relative abundance, seasonal distribution, and habitat correlations. When species seemed to be excluded from one of the reservations, the supposedly appropriate habitat was examined closely in an attempt to determine what ecological differences between the two reservations might account for the absence.

The combined fauna was examined to determine the probable origins of eastern Kansas crane flies. Comparative data were obtained from similar studies made by J. Speed Rogers (1942) at the George Reserve in southeastern Michigan, and B. A. Foote (1956) in Delaware County, Ohio. Overall range data were obtained from *A Catalog of the Diptera of America North of Mexico* (Stone, et al., 1965). Included are a brief account of the habitat, abundance, etc., of each species encountered and a taxonomic key to local species.

Until this study, none of the following species had been reported within a 500 mile radius of Lawrence, Kansas: *Nephrotoma*

alterna, *Tipula* (L.) *perlongipes*, *Limonia* (D.) *haeretica*, *Dicranoptycha elsa*, *D. megaphallus*, *D. septemtrionis*, *Gonomyia* (L.) *manca*, *Ormosia arcuata*, *O. ingloria*, *Tasiocera* (D.) *ursina*, and *Molophilus pubipennis*.

GENERAL FEATURES OF THE STUDY AREAS

EASTERN KANSAS

Kansas is at the geographic center of the contiguous continental United States. Except for its hilly eastern part, it is a plain sloping gradually downward to the east and is usually regarded as a prairie state. However, within its borders there are approximately 1,358,000 acres of forest, mostly in the eastern hills, where edaphic conditions and an annual precipitation of approximately 34.75 inches are adequate for upland forests. Some expansion of forests westward has followed agricultural activity and the cessation of prairie fires. Eastern Kansas is in a transition zone between the eastern forests and the central plains.

DOUGLAS COUNTY

Douglas County is in northeastern Kansas. Its main topographic features are the Kansas and Wakarusa river valleys, draining eastward, and uplands formed by differential erosion of the nearly horizontal beds of limestone, shale and sandstone. In the eastern part of the county, plains have

developed on glacial deposits. The climate is humid, with cold winters and warm to hot summers, three-fourths of the annual precipitation falling during the warm season from April through September. Most of the county is now agricultural land.

THE BREIDENTHAL RESERVE

The Breidenthal Reserve (Baldwin Woods) comprises 110 acres of mixed broad-leaf deciduous forest in southern Douglas County, about 2 miles north of Baldwin City and 15 miles southeast of Lawrence. It includes part of the steep slope along the south side of the Wakarusa River Valley and is drained by Coal Creek. The area is mostly oak-hickory forest, with variation depending upon the locality and drainage. The creek is narrowly bordered with flood-plain species of trees. Low oak-hickory forest occurs regularly on the moderately mesic hillside and north-facing slopes, while drier, upland, oak-hickory forest grows on the south-facing slopes.

THE UNIVERSITY OF KANSAS NATURAL HISTORY RESERVATION

The University of Kansas Natural History Reservation is at the north edge of the Kansas River Valley in northern Douglas County, about 5 miles northeast of Lawrence. Two intermittent brooks drain its 590 acres, one in the northwestern part, the other in the southeastern part. A pond, formed by damming of the northwestern brook, has a small swamp around its north-eastern edge. Most of the Reservation supports broad-leaf deciduous forest, with scattered grassy openings. This area had been heavily grazed before it became the Reservation in 1948, its present vegetation is still in a successional state.

CRANE FLY HABITATS

Some adult crane flies in the two study areas are restricted to a single type of habi-

tat, while others are widespread. Humidity and temperature affect flight and other activities, so that distribution of adult flies only approximates that of the larvae; yet there is usually a close correlation. Six, general, crane fly habitats exist in the study areas. Following the description of each, below, is a list of the species of crane flies recorded from it.

BOTTOMLAND FOREST

The Breidenthal Reserve has bottomland forest along Coal Creek that contains mixed species of oak and hickory (*Quercus macrocarpa*, *Q. alba*, *Q. rubra*, *Carya ovata*, *C. cordiformis*), sycamore (*Platanus occidentalis*), and American elm (*Ulmus americana*). The shrub layer is poorly developed. The vernal herbaceous flora is very well developed. Undergrowth includes nettle (*Urtica procera*), and jewelweed (*Impatiens capensis*), with sparse patches of grass. There is sporadic flooding in spring and early summer, and a dry season in late summer. This is a mesic area. Crane flies present are: *Dolichopeza tridenticulata*, *Nephrotoma alterna*, *N. euceroidea*, *N. macrocera*, *N. polymera*, *Tipula trivittata*, *T. duplex*, *T. flavoumbrosa*, *T. mallochii*, *T. ultima*, *T. furca*, *T. sayi*, *T. strepens*, *Limonia fallax*, *L. globithorax*, *L. tristigma*, *L. divisa*, *L. pudica*, *L. domestica*, *Heliopsis flavipes*, *Dicranoptycha septentrionalis*, *D. tigrina*, *Epiphragma fasciapennis*, *E. solatrix*, *Pilaria tenuipes*, *Cladura flavoferruginea*, *Gnophomyia tristissima*, *Gonomyia florens*, *G. manca*, *G. sulphurella*, *Erioptera cana*, *E. vespertina*, *E. caloptera*, *E. needhami*, *E. armata*, *Ormosia romanovichiana*, *Tasiocera ursina*, *Molophilus pubipennis*.

GRASSLAND

Grasslands in which Tipulidae occur in the two study areas are ecotone areas between small grassy fields and the edge of woods. These are too dry for most crane

flies, but some species whose larval stages feed on the roots of certain herbaceous plants growing in the grassland occur as adults in the ecotone of the grassland and woods. Such species are: *Nephrotoma ferruginea*, *Tipula bicornis*, *T. flavibasis*, *T. triplex*, *T. paterifera*, *T. ultima*, *Erioptera cana*, *E. septemtrionis*.

OAK-HICKORY FORESTS

The oak-hickory forests of the Breidenthal Reserve are in stable climax, dominated by shagbark hickory (*Carya ovata*), chestnut oak (*Quercus muehlenbergii*), red oak (*Quercus rubra*), and red elm (*Ulmus rubra*). Understory trees include ironwood (*Ostrya virginiana*), red mulberry (*Morus rubra*), redbud (*Cercis canadensis*), and pawpaw (*Asimina triloba*). The undergrowth is generally open with some growth of poison ivy (*Rhus radicans*), wild gooseberry (*Ribes missouriense*) and buckbrush (*Symphoricarpos orbiculatus*). Leaf litter and, beneath it, leaf mold are present over most of the level areas and gentler slopes. Fallen trees and decaying limbs there are usually too dry to harbor most crane fly larvae. Mats of dry mosses are scattered on the ground surface. Oak-hickory forests are too dry for most crane flies; few species are present: *Nephrotoma ferruginea*, *Tipula disjuncta*, *T. duplex*, *T. fuliginosa*, *T. perlongipes*, *T. tuscarora*, *T. stonei*, *Limonia triocellata*, *L. domestica*, *Dicranoptycha elsa*, *D. megaphallus*, *D. septemtrionis*, *Cladura flavoferruginea*, *Gonomyia subcinerea*, *Erioptera cana*.

STREAMS

The small, intermittent brooks on the Natural History Reservation ordinarily flow only in spring and early summer. They dry up quickly by mid-summer, although pools may persist in the stream beds for several weeks after flow has ceased. Coal Creek in the Breidenthal Re-

serve flows from early spring until August, and has small pools which persist through September. A few, small, ravine tributaries feed into it in spring. Several species of crane flies inhabit the banks and beds of these streams. Their larvae probably occur in submerged, rotten, tree branches, and in the algae or mosses covering rocks in and along the streams. These are: *Dolichopeza obscura*, *D. tridenticulata*, *D. walleyi*, *Tipula furca*, *T. strepens*, *Limonia rara*, *L. annulata*, *L. humidicola*, *L. bryanti*, *L. domestica*, *L. lecontei*, *L. communis*, *Erioptera armata*, *Ormosia romavichiana*, *Tasiocera ursina*, *Molophilus pubipennis*.

SWAMP

The artificial pond on the Natural History Reservation supports a small swamp of recent origin around its northeastern edge. Tree species common here are willows (*Salix* spp.), American elm (*Ulmus americana*), and honey locust (*Gleditsia triacanthos*). No shrub stratum is developed. The water rises and covers most of the area during spring and early summer. At the low-water stage the area is almost completely covered by smartweeds (*Polygonum hydropiper*). The moist-to-wet soil is the preferred habitat for the larvae of several species of crane flies. They are: *Nephrotoma alterna*, *N. eucera*, *N. euceroidea*, *N. macrocera*, *N. polymera*, *Tipula ignobilis*, *T. ultima*, *T. furca*, *T. strepens*, *T. tricolor*, *Limonia tristigma*, *L. pudica*, *L. domestica*, *Dicranoptycha pallida*, *Epiphragma fasciapennis*, *E. solatrix*, *Pilaria imbecilla*, *P. quadrata*, *P. tenuipes*, *Atarba picticornis*, *Teucholabis lucida*, *Erioptera vespertina*, *E. caliptera*, *E. parva*, *E. graphica*, *Tasiocera ursina*, *Molophilus hirtipennis*, *M. pubipennis*.

VALLEY HILLSIDE WOODS

In the Breidenthal Reserve, low oak-hickory forests grow on well-drained soils

on the gently sloping, moist to mesic, north-facing hillsides. Ground cover species include tick trefoil (*Desmodium glutinosum*), Virginia creeper (*Parthenocissus quinquefolia*), and mayapple (*Podophyllum peltatum*).

The valleys in the Natural History Reservation are wooded with American elm (*Ulmus americana*), honey locust (*Gleditsia triacanthos*), black walnut (*Juglans nigra*), and osage orange (*Maclura pomifera*), with dogwood (*Cornus drummondii*) and wild plum (*Prunus americana*) forming the understory. Shrubs present are poison ivy (*Rhus radicans*), wild gooseberry (*Ribes missouriense*), buckbrush (*Symphoricarpos orbiculatus*), and brambles (*Rubus* spp.). The herb stratum is sparsely developed, only where the tree canopy has been broken.

In the spring, these two previously described habitats are moderately mesic. Fallen tree trunks in various stages of decomposition, and soil covered by damp and friable humus form a habitat for larvae of several species of crane flies. These include the following: *Dolichopeza tridenticulata*, *D. walleyi*, *Nephrotoma alterna*, *N. euceroidea*, *N. macrocera*, *N. virescens*, *Tipula trivittata*, *T. dietziana*, *T. dorsimacula*, *T. duplex*, *T. flavoumbrosa*, *T. fuliginosa*, *T. mallochii*, *T. morrisoni*, *T. translucida*, *T. integra*, *T. unimaculata*, *Limonia cinctipes*, *L. fallax*, *L. immatura*, *L. divisa*, *L. haeretica*, *L. immodestoides*, *L. liberta*, *L. pudica*, *L. domestica*, *Dicranoptycha elsa*, *D. megaphallus*, *D. pallida*, *D. sobrina*, *Epiphragma fasciapennis*, *E. solatrix*, *Pseudolimnophila contempta*, *Pilaria tenuipes*, *Atarba picticornis*, *Elephantomyia westwoodi*, *Cladura flavoferruginea*, *Teucholabis complexa*, *Gonomyia subcinerea*, *Erioptera cana*, *Ormosia ingloria*.

METHODS

This report is based largely upon field

observations and collections made in the two study areas described. Collections were made from May 1974 to September 1975 as often as time permitted. Throughout the peak-emergence periods of adult flies, collections were conducted on alternate days at the Breidenthal Reserve and the Natural History Reservation. At first all varieties of habitats were searched. Later, searches were concentrated on several specific sites believed to represent the principal types of crane fly habitats.

Net sweeping was the basic method of collecting. All possible hiding places were explored with the net. Specimens were taken either at their resting site, or in the air as they fled. No more than 20 specimens per species were captured at each habitat on each trip. All flies caught by net were mounted.

In the spring of 1975, a Malaise trap was set in the bottomland along the creek near the mouth of a ravine on the Breidenthal Reserve; another was set in the swamp woods at the Natural History Reservation. Each was checked at five-day intervals, and all flies trapped were kept in alcohol.

Ecological information recorded about the specimens included weather conditions at time of collection, type of habitat with which flies were associated, microhabitat where flies were taken, relative abundance of each species, data on behavior of the flies (when appropriate), and other noteworthy details. Larvae were taken and rearing data were obtained whenever possible.

SEASONAL DISTRIBUTION

In eastern Kansas adult crane flies usually emerge during wet seasons. At both reservations their appearance begins with *Erioptera cana* in late March, reaches a peak period in May and early June, and ends with *Cladura flavoferruginea* in mid-October. Winter crane flies, *Chionea stoneana*, appear in January.

Many species have single, short, clear-cut adult seasons and can be classified as univoltine, spring, summer, or autumnal forms, according to the flight periods of the adults. However, some species complete two generations per year and have two flight periods. Temporal disjunction between generations is either total or partial. For example, adults of *Tipula* (*Yamatotipula*) *furca* first emerge in late April, disappear in summer, and recur in early September, while adults of *Nephrotoma macrocera* can be found on the wing from May until September. Multivoltine species such as *Erioptera cana*, fly as adults from March to October. Temporary fluctuations in environmental factors markedly affect the number of generations during the summer.

Table 1 summarizes seasonal distribution of adults. In the table, each month is divided into ten-day intervals, and the symbols 'X', 'x', and '-' are used to indicate, respectively, the peak period (common), the intermediate period (numerous), and the period of least abundance (rare) within the species. At the right, local occurrence of the species is summarized; Br.—Breidenthal Reserve; and NH.—Natural History Reservation.

RELATIVE ABUNDANCE OF SPECIES

Each major habitat was visited for about half an hour on each collecting trip. Categories indicating relative abundance and distributional pattern were modified from Rogers (1942). Abundance is expressed as the number of flies that could be caught per half-hour: abundant—more than 20; common—10-20; numerous—fewer than 10; rare—one only. Ecological distribution: widespread—present in four to six habitats; general—continuous in two adjacent habitats; local—restricted to one habitat.

ANNOTATED LIST OF SPECIES

In this annotated list, the brief account of each species includes its habitat, flight period, relative abundance, and previously known range. Br.—Breidenthal Reserve; NH.—Natural History Reservation.

1. *Dolichopeza* (*Oropeza*) *obscura* (Johnson)

Br. 1975; May 22-June 10. Also taken by G. W. Byers on August 30, 1961; bivoltine.

Only three specimens were taken in 1975, found associated with other species of *Dolichopeza* under a wooden culvert in a woodland ravine.

Previously known range: Alberta to Nova Scotia, southward to Arkansas and Florida.

2. *Dolichopeza* (*Oropeza*) *tridenticulata* Alexander

Br. NH. 1974-1975; May 23-June 26, and a single male on August 7, 1974; bivoltine.

Common, to locally abundant in well-shaded, mesic situations, such as beneath a wooden culvert, under protruding rocks along stream bed, and in the shade of upturned, shallow, tree roots. Usually the flies were found hanging from the roof of their nesting places with the hind legs pendant.

Previously known range: Manitoba to Quebec and Maine, southward to Missouri and Georgia.

3. *Dolichopeza* (*Oropeza*) *walleyi* (Alexander)

Br. NH. 1974-1975; May 22-June 17, and July 16-August 7; bivoltine.

This species is common in May and June, but rare in August. Most specimens were from wet, well-shaded places. One rich collecting spot was the wooden culvert in Br. Adults were usually taken where *tridenticula* was also common, or resting in low shrubs and herbs.

TABLE 1

Summary of Seasonal Distribution of Adults

No.	Species	Mar.			Apr.			May			June			July			Aug.			Sept.			Oct.			Br.	NH.
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3		
1.	<i>Dolichopeza</i> (O.) <i>obscura</i> (Johnson)										----															x	
2.	<i>Dolichopeza</i> (O.) <i>tridenticulata</i> Alex.										--xXXx--						-									x	x
3.	<i>Dolichopeza</i> (O.) <i>walleyi</i> (Alex.)										-xxXXx-						-----									x	x
4.	<i>Nephrotoma</i> <i>alterna</i> (Walker)										-xXXxxx--							-								x	x
5.	<i>Nephrotoma</i> <i>eucera</i> (Loew)										-																x
6.	<i>Nephrotoma</i> <i>euceroidea</i> Alex.										--xXXXx-															x	x
7.	<i>Nephrotoma</i> <i>ferruginea</i> (Fabr.)							-----			xxx--							-----			x---					x	x
8.	<i>Nephrotoma</i> <i>macrocera</i> (Say)							-----			xxXxx--							-----			xxx-					x	x
9.	<i>Nephrotoma</i> <i>polymera</i> (Loew)							---			xXXx-															x	x
10.	<i>Nephrotoma</i> <i>virescens</i> (Loew)										---															x	
11.	<i>Tipula</i> (P.) <i>ignobilis</i> Loew										--																x
12.	<i>Tipula</i> (P.) <i>trivittata</i> Sav							--			x-															x	x
13.	<i>Tipula</i> (L.) <i>australis</i> Doane							--																			x
14.	<i>Tipula</i> (L.) <i>bicornis</i> Forbes										-xXXx-															x	x
15.	<i>Tipula</i> (L.) <i>dietziana</i> Alex.										xx-															x	x
16.	<i>Tipula</i> (L.) <i>disjuncta</i> Walker										x--																x
17.	<i>Tipula</i> (L.) <i>dorsimacula</i> Walker							-xx-																		x	x
18.	<i>Tipula</i> (L.) <i>duplex</i> Walker										--xXXXXx-----															x	x
19.	<i>Tipula</i> (L.) <i>flavibasis</i> Alex.										-----							x-								x	x
20.	<i>Tipula</i> (L.) <i>flavovimbrosa</i> Alex										--xXXx-															x	x
21.	<i>Tipula</i> (L.) <i>fuliginosa</i> (Say)										-xx--															x	x
22.	<i>Tipula</i> (L.) <i>mallochii</i> Alex.										-xxxxx-															x	x
23.	<i>Tipula</i> (L.) <i>morrisoni</i> Alex.										---x--															x	x
24.	<i>Tipula</i> (L.) <i>perlongipes</i> Johnson										-----															x	x
25.	<i>Tipula</i> (L.) <i>species</i> near <i>T. perlongipes</i>										-----															x	
26.	<i>Tipula</i> (L.) <i>translucida</i> Doane										---																x
27.	<i>Tipula</i> (L.) <i>triplex</i> Walker										-xXx-															x	x
28.	<i>Tipula</i> (L.) <i>integra</i> Alex.										-xXx---															x	x
29.	<i>Tipula</i> (L.) <i>tuscarora</i> Alex.										--x-															x	
30.	<i>Tipula</i> (P.) <i>paterifera</i> Alex.																								-xX-	x	x
31.	<i>Tipula</i> (P.) <i>ultima</i> Alex.																								---xXx---	x	x
32.	<i>Tipula</i> (Tr.) <i>unimaculata</i> Loew)													---x---												x	x
33.	<i>Tipula</i> (Tr.) <i>stonei</i> Alex.																								-xx-	x	
34.	<i>Tipula</i> (Y.) <i>furea</i> Walker										--xXx-----														-x-	x	x

No.	Species	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Br.	NH.		
		1	2	3	1	2	3	1	2			3	1
71.	<u>Elephantomyia</u> (E.) <u>westwoodi</u> O. S.									x	x		
72.	<u>Cladura</u> (C.) <u>flavoferruginea</u> O. S.									-xXx-	x	x	
73.	<u>Chionea</u> <u>stoneana</u> Alex.									x			
74.	<u>Teucholabis</u> (T.) <u>complexa</u> O. S.										x		
75.	<u>Teucholabis</u> (T.) <u>lucida</u> Alex.									-xXx-	x	x	
76.	<u>Gnophomyia</u> <u>tristissima</u> O. S.									-xXx--xXx--	x	x	
77.	<u>Gonomyia</u> (G.) <u>florens</u> Alex.											x	
78.	<u>Gonomyia</u> (G.) <u>kansensis</u> Alex.											x	
79.	<u>Gonomyia</u> (G.) <u>subcinerea</u> O. S.									-xXxXx--x--x--	x	x	
80.	<u>Gonomyia</u> (L.) <u>manca</u> (O. S.)									--x--x--x--	x		
81.	<u>Gonomyia</u> (L.) <u>sulphurella</u> O. S.											x	
82.	<u>Erioptera</u> (S.) <u>cana</u> (Walker)									-xXxXx--x--x--	x	x	
83.	<u>Erioptera</u> (E.) <u>septentrionis</u> O. S.											x	
84.	<u>Erioptera</u> (E.) <u>vespertina</u> O. S.											x	x
85.	<u>Erioptera</u> (M.) <u>caliptera</u> (Say)									-xXxx--x--x--	x	x	
86.	<u>Erioptera</u> (M.) <u>needhami</u> Alex.											x	
87.	<u>Erioptera</u> (M.) <u>parva</u> O. S.											x	
88.	<u>Erioptera</u> (H.) <u>armata</u> O. S.									-xxXXxx--x--x--	x	x	
89.	<u>Erioptera</u> (P.) <u>graphica</u> O. S.											x	
90.	<u>Ormosia</u> <u>arcuata</u> (Doane)											x	
91.	<u>Ormosia</u> <u>inyloria</u> Alex.									--		x	
92.	<u>Ormosia</u> <u>romanovichiana</u> (O. S.)									-x--		x	
93.	<u>Tasiocera</u> (D.) <u>ursina</u> (O. S.)									-Xx-		x	x
94.	<u>Molophilus</u> <u>hirtipennis</u> (O. S.)											x	
95.	<u>Molophilus</u> <u>pubipennis</u> (O. S.)									-xXxx--		x	x

Larvae were taken on April 3, 1974, from a thin carpet of moss covering a sodden, decayed log lying on the forest floor below the dam in NH.

Previously known range: Alberta to Nova Scotia, southward to Kansas and Florida.

4. *Nephrotoma alterna* (Walker)

Br. NH. 1974; June 5-July 16, with a single record for August 31; bivoltine.

Numerous in the bottomland woods,

and in the moist thickets along streams; a few individuals from the low oak-hickory forests. On June 28, 1974, two females were found ovipositing into wet soil at the foot of a slope, about three feet from the margin of Coal Creek.

Previously known range: Michigan to Nova Scotia, southward to Florida.

5. *Nephrotoma eucera* (Loew)

NH. 1974; June 13.

Rare, one male taken from the tall,

luxuriant herbage around the swamp.

Previously known range: Wisconsin to Quebec and Massachusetts, southward to Kansas, Tennessee, and Virginia.

6. *Nephrotoma eucroides* Alexander

Br. NH. 1974-1975; May 23-June 26; univoltine.

Fairly common in grassy areas around the swamp, and in the bottomland woods where wood nettles and jewelweeds grow luxuriantly, less common in mesic hillside woods. When alarmed, flies up into the trees. This is the most common species of its genus found in the NH; larvae not found at Br. or NH. but were taken at Hole-in-the-Rock, 12 miles south of Lawrence, from soil next to a well-rotted stump.

Previously known range: Michigan to New Brunswick and Connecticut.

7. *Nephrotoma ferruginea* (Fabricius)

Br. NH. 1974-1975; April 21-June 29 and August 12-September 26; bivoltine (second generation records based on collections by G. W. Byers in 1969).

The first species of *Nephrotoma* to emerge in spring, and the only *Nephrotoma* found in grassland in the study areas. Numerous in the margins of the grassy fields and in adjacent woods. Rare in grassy patches along water courses. This species comes rather freely to light at night.

Previously known range: Eastern North America, westward to Colorado, southward to Texas.

8. *Nephrotoma macrocera* (Say)

Br. NH. 1974-1975; May 8-September 21. This species occurs throughout the summer with two peaks of emergence, in June and September; bivoltine.

This is the most abundant species of *Nephrotoma* in Br., fairly common in bottomland forests and more mesic parts of

the oak-hickory; less common in the swampy area.

About a dozen, callow adults were taken on September 13, 1975, in grassy patches along Coal Creek, two days after a week-long rainy period.

Previously known range: Wisconsin to Maine, southward to Kansas, Tennessee, and Florida.

9. *Nephrotoma polymera* (Loew)

Br. NH. 1974-1975; May 22-June 28; univoltine.

Numerous to common in bottomland forests, and in grassy areas around the swamp. Rare in thickets along creeks.

Previously known range: Wisconsin to New Hampshire, southward to Kansas, Tennessee, and South Carolina.

10. *Nephrotoma virescens* (Loew)

Br. 1974-1975; June 11-July 23; univoltine.

Rare; only four specimens taken from wooded margins of Coal Creek, two of them, a mating pair, on June 11, 1974.

Previously known range: Michigan to New Hampshire, southward to Illinois and Florida.

11. *Tipula (Pterelachisus) ignobilis* (Loew)

NH. 1975; May 30-June 1; univoltine.

Rare and local, only seven specimens taken; three males from a small swarm at a small, vernal stream near the pond; two mating pairs from a moss-covered, tree trunk nearby on June 1, 1975. Adults were reared from larvae found in a mat of wet mosses on a cliff at Hole-in-the-Rock, 12 miles south of Lawrence.

Previously known range: Illinois to New Brunswick, southward to Tennessee and North Carolina.

12. *Tipula (Pterelachisus) trivittata* Say

Br. NH. 1975; May 3-19; univoltine.

Rare; from the bottomland forests, or from moist to mesic hillside woods. The Malaise trap in the Br. caught four individuals of this species.

Previously known range: Iowa to Newfoundland, southward to Tennessee and South Carolina.

13. *Tipula (Lunatipula) australis* Doane

NH. May 1958 and May 1960; univoltine.

Records based on collections made by G. W. Byers. A spring species, found in 1958 on the shaded bank of the overflow channel around the dam (NH). In 1960, recorded from the brushy hillside just below an old limestone quarry in the NH.

Previously known range: Texas to Georgia, northward to Maryland.

14. *Tipula (Lunatipula) bicornis* Forbes

Br. NH. 1974-1975; May 7-June 4; univoltine.

Abundant and local in grassland, rare or absent elsewhere; adults usually on pink clover or other, taller, herbaceous plants in grassy fields. On the morning of May 8, 1975, about 20 pairs were observed in copulation, one foot or less above the ground in a grassy field along the highway at the edge of the Br. In every instance the male was fully matured, the female slightly or very teneral.

Pupae were taken on May 4, 1975, in grassland, about 6 mm. beneath the ground surface, which was covered by a thin mat of mosses. Adults emerged on 10 May; several of these and some of the pupae were killed by fungus, *Massospora tipulae* Porter (identified by Dr. R. W. Lichwardt of the University of Kansas Department of Botany).

Previously known range: Wisconsin to New Brunswick, southward to Kansas, Tennessee, and Virginia.

15. *Tipula (Lunatipula) dietziana*

Alexander

Br. NH. 1975; April 28-May 6; univoltine.

Numerous and general on moist, north-facing hillsides. In morning and late afternoon many males were seen flying about over the damp leaf mold well up the slopes of the hillside woods, probably in search of emerging females.

Previously known range: Kansas to New York, and South Carolina.

16. *Tipula (Lunatipula) disjuncta* Walker

NH. 1975; April 29-May 7; univoltine.

Numerous and general in oak-hickory forests, rare on lower mesic hillsides. Males are very active during the day, searching for emerging females. All specimens taken were males; females recorded from G. W. Byers' collection of May 10, 1960.

Previously known range: Iowa to Vermont, southward to Illinois and Delaware.

17. *Tipula (Lunatipula) dorsimacula*

Walker

Br. NH. 1975; April 20-May 4; univoltine.

The earliest of the subgenus *Lunatipula* to emerge in the spring; numerous on mesic hillsides and in vernal seepage areas. In the morning, males were usually found flying low over the damp leaf mold, together with males of *T. dietziana*.

Previously known range: British Columbia to Nova Scotia, southward to California and New Jersey.

18. *Tipula (Lunatipula) duplex* Walker

Br. NH. 1974-1975; May 27-July 26; univoltine, with a long adult flight period, at its peak in mid-June. Females rare after mid-July. The long season is probably correlated with local differences in habitats.

Abundant in oak-hickory and hillside

woods, common in bottomland forests, and rare in the swamp area, this is the most abundant and conspicuous *Tipula* of mid-June. Adults range throughout wooded habitats.

Previously known range: Kansas to Nova Scotia and Florida.

19. *Tipula (Lunatipula) flavibasis*
Alexander

Br. NH. 1974-1975; June 19-July 24; univoltine.

The last species of *Lunatipula* to emerge in summer; numerous in margins of rather dry woodlands, spreading into adjacent, grassy fields.

Previously known range: Kansas.

20. *Tipula (Lunatipula) flavoumbrosa*
Alexander

Br. NH. 1974-1975; May 8-June 10; univoltine.

Abundant in the low, damp parts of the oak-hickory and bottomland forests, rare from drier and open parts of hillside woods. Most often found on upper leaves of low shrubs.

Previously known range: Kansas to Michigan, South Carolina, and Florida.

21. *Tipula (Lunatipula) fuliginosa* (Say)

Br. NH. 1974-1975; May 17-June 10; univoltine.

Numerous in drier parts of hillside woods, a few in the oak-hickory woods. Females usually in damp thickets along the creek and moist, grassy patches in bottomland woods.

Previously known range: Kansas to Ontario and New Hampshire, southward to North Carolina.

22. *Tipula (Lunatipula) mallochi*
Alexander

Br. NH. 1974-1975; May 12-June 17; univoltine.

Abundant in moist, low oak-hickory, in

bottomland forests and damp thickets along the creeks, common in wooded margins of the swamp, widespread in woods in late May. Larvae were taken at Hole-in-the-Rock beneath and in leaf mold of the forest floor. These began to pupate April 26, 1974, and adults started emerging on May 3.

Previously known range: Missouri to Maryland and Florida.

23. *Tipula (Lunatipula) morrisoni*
Alexander

Br. NH. 1974-1975; May 23-June 17, univoltine.

Numerous in open woods and drier hillside woods; adults usually among lower leaves of trees.

Previously known range: Kansas to Rhode Island, southward to Mississippi, and South Carolina.

24. *Tipula (Lunatipula) perlongipes*
Johnson

Br. NH. 1974-1975; May 30-June 20; univoltine.

Rare, on drier, sparsely wooded, oak-hickory slopes; distinguished from other members of the *triplex* subgroup by the relatively narrow, yellow wings, and by male genitalia structures.

Previously known range: Florida, North Carolina to Indiana.

25. *Tipula (Lunatipula) triplex* group,
species near *T. perlongipes*

Br. 1975; May 31-June 17; univoltine.

Rare in bottomland woods and more mesic parts of the low oak-hickory. It differs from *perlongipes* in the structure of the male hypopygium, which lacks the median depressed lobe on the 8th sternum (Fig. 29). The habitat distribution of this species is more like that of *T. flavoumbrosa*. Rogers (1942) called this species *Tipula* species, *triplex* group near *flavoumbrosa*.

Previously known range: Michigan, westward to Iowa, and Missouri (Rogers, 1942, p. 68).

26. *Tipula (Lunatipula) translucida*
Doane

NH. 1974-1975; June 10-June 17; univoltine.

Rare and local in a narrow thicket along the overflow channel at the pond in the NH. All specimens caught were males, usually among leaves of taller buckbrush and lower branches of trees.

Previously known range: Illinois to Pennsylvania, southward to Oklahoma and South Carolina.

27. *Tipula (Lunatipula) triplex* Walker

Br. NH. 1974-1975; May 7-May 31; univoltine.

Common in the ecotone between grassy fields and edges of woods. Several teneral adults were taken from the grassy field along with *T. bicornis* on May 8, 1975. Rare or absent in other habitats.

Previously known range: Alberta to Newfoundland, southward to Wisconsin and Virginia.

28. *Tipula (Lunatipula) integra*
Alexander

Br. NH. 1974-1975; May 8-June 6; univoltine.

Common in the wetter, low, oak-hickory and hillside woods, absent in grassland, rare in bottomland forests. Resembles *T. triplex*, from which it differs in details of male genitalia. The submedian teeth of the 8th sternum are broad at base with round apex in this species (Fig. 26). It also appears to have a somewhat different habitat.

Rogers (1942) believed this form is distinct from either *triplex* or *umbrosa* and used the term *Tipula triplex* group form C for it. Alexander (1962) described it as *Tipula triplex integra*, a race of *triplex*.

However, the conspicuous differences in male genitalial structure, habitat correlation, and occurrence together with the typical form suggest it is a distinct species.

Previously known range: Michigan, Indiana.

29. *Tipula (Lunatipula) tuscarora*
Alexander

Br. 1974-1975; May 17-June 2; univoltine.

Rare in open woodland; easily flushed and usually alights on lower leaves of trees. All specimens taken were males.

Previously known range: Missouri to Maryland, southward to South Carolina.

30. *Tipula (Platytipula) paterifera*
Alexander

Br. NH. 1974-1975; October 10-21; univoltine.

One female was taken in a grassy patch along Coal Creek in 1974. In 1975 this species was found abundant in the patches of *Polygonum* which conceal the pond shoreline at NH. It was also common in the grassland where *T. bicornis* was found in the spring. Adults are active in late afternoon. This species comes frequently to light at the home of the resident naturalist at NH.

Previously known range: Tennessee, Missouri.

31. *Tipula (Platytipula) ultima* Alexander

Br. NH. 1974-1975; August 29-October 10; univoltine.

Abundant in the transition zones between the swamp and mesic hillside woods, this species also spreads into adjacent grasslands. About 60 larvae were taken on April 3, 1974, in saturated soil on the bank of the overflow channel around the dam at NH. These were reared and observed in the laboratory. They stopped feeding and moved from the saturated soil to drier soil in early July, although pupation did

not occur until about a week before emergence, which started on September 3, 1974.

Previously known range: Saskatchewan to Nova Scotia, southward to Wyoming, Mississippi, and Florida.

32. *Tipula (Trichotipula) unimaculata*
(Loew)

Br. NH. 1974-1975; June 24-July 16; univoltine.

Rare in wet areas in hillside woods. Often found resting on algae-covered tree trunks near hillside seepage areas.

Previously known range: Michigan to Maine, southward to Illinois, and North Carolina.

33. *Tipula (Trichotipula) stonei*
Alexander

Br. 1974-1975; September 5-21; univoltine.

Occasionally numerous on open hill-sides; adults found resting on leaves of lower branches of trees.

Previously known range: Michigan to Ontario, southward to Kansas and Florida.

34. *Tipula (Yamatotipula) furca* Walker

Br. NH. 1974-1975; April 21-June 29, and August 31-September 8; bivoltine.

Common in the swamp area at NH. and in grassy patches along Coal Creek; rare in damp thickets around the swamp.

Females were observed ovipositing into saturated soil at the margin of the pond and along the bank of a brook which feeds into the pond at NH.

Previously known range: Kansas to Quebec and Maine, southward to Texas and Florida.

35. *Tipula (Yamatotipula) sayi* Alexander

Br. 1974-1975; September 13-14; univoltine.

Only two females taken, both from a grassy clearing in the flood-plain woods along Coal Creek.

Previously known range: Iowa to Newfoundland, southward to Louisiana and Florida, Bermuda.

36. *Tipula (Yamatotipula) strepens* Loew

Br. NH. 1974-1975; May 1-June 26, and July 24-August 17; bivoltine.

Common in grassy areas around the swamp and in grassy patches along Coal Creek. Numerous in the damp thicket around the swamp, usually found hanging in buck brush.

T. strepens and *T. furca* overlap to some extent in their habitat; *strepens* apparently is able to tolerate lower humidity than *furca*.

Previously known range: Kansas to Newfoundland, southward to New Jersey.

37. *Tipula (Yamatotipula) tricolor*
Fabricius

NH. 1975; May 23-June 1; apparently univoltine here, though bivoltine elsewhere in eastern U.S.

Rare and local in the swamp area; all three specimens were taken from patches of *Polygonum hydropiper* growing at the edge of the pond.

Previously known range: Wisconsin to Quebec and Maine, southward to Arkansas and Florida.

38. *Limonia (Limonia) globithorax*
(Osten Sacken)

Br. 1974; August 17-September 18; univoltine.

Numerous and local; six specimens were taken from a small swarm above a partially submerged, fallen, tree trunk in Coal Creek. Three records were from damp, decayed wood in a nettle patch along the creek.

Previously known range: Wisconsin to Newfoundland, southward to Tennessee and Florida.

39. *Limonia (Limonia) rara*
(Osten Sacken)

Br. NH. 1974-1975; June 14-July 23, and August 12-September 18; bivoltine.

Numerous and general in its restricted habitats along water courses. Most specimens were resting on moist, moss-covered tree trunks about 18 inches above the ground, in mesic flood plain forest.

Previously known range: Iowa and Wisconsin to New York, southward to Florida.

40. *Limonia (Limonia) tristigma*
(Osten Sacken)

Br. NH. 1974-1975; June 10-July 3; univoltine.

The most abundant species of subgenus *Limonia* in two study areas. Abundant in the flood plain forests and swamp, especially in places where nettle and jewelweed are luxuriant, occasionally hanging from stems and leaf margins of tall herbs and shrubs.

Previously known range: Alberta to New Brunswick, southward to Tennessee and North Carolina.

41. *Limonia (Metalimnobia) cinctipes*
(Say)

Br. NH. 1974; June 11-25; univoltine.

Rare, in mesic, low oak-hickory and the thickets between hillside woods and swamp. A female was found resting on the shady side of a tree trunk with wings folded over the back and all legs outspread.

Previously known range: Alberta to Newfoundland, southward to Mississippi and Florida.

42. *Limonia (Metalimnobia) fallax*
(Johnson)

Br. NH. 1974-1975; May 3-June 25, and September 5-14; bivoltine.

Numerous in the low, oak-hickory forests, adults usually standing on leaf litter

around seepage or wet spots, or on moist, decayed tree stumps.

Previously known range: Michigan to New Jersey, southward to Oklahoma and North Carolina.

43. *Limonia (Metalimnobia) immatura*
(Osten Sacken)

NH. 1974-1975; June 19-July 2; univoltine.

Rare, in mesic hillside thickets. Two of the three specimens were from the same habitat as *L. cinctipes*, the other one from jewelweeds in bottomland woods.

Previously known range: Maine to British Columbia, southward to Florida.

44. *Limonia (Metalimnobia) triocellata*
(Osten Sacken)

Br. NH. 1974-1975; May 24-June 26, and September 5-14; bivoltine.

Numerous in upland woods, where the scattered undergrowth is about two feet high. Adults often rest on shrubs. Apparently this species can tolerate low humidity better than other members of its genus.

Previously known range: Alberta to Nova Scotia, southward to Tennessee and Georgia.

45. *Limonia (Discobola) annulata*
(Linnaeus)

Br. 1975; July 16.

Rare and local, only two males having been taken from dry moss-covered bases of trees in bottomland woods bordering Coal Creek.

Previously known range: British Columbia to Newfoundland, southward to Oregon, Tennessee, and Virginia; also found in Eurasia, south to New Guinea.

46. *Limonia (Dicranomyia) divisa*
Alexander

Br. NH. 1974-1975; April 21-July 16. Continuous flight period, but a definite

peak of abundance in late May; probably bivoltine.

Numerous to common in bottomland woods and mesic parts of oak-hickory woods, especially in shaded ravines having moist to wet banks. Females were observed ovipositing in moist moss on fallen trees.

Previously known range: Iowa to Massachusetts, southward to Missouri and Florida and the Greater Antilles.

47. *Limonia (Dicranomyia) haeretica*
(Osten Sacken)

Br. 1974-1975; May 3-June 10; univoltine.

Numerous in vernal, seepage areas; most specimens taken in 1975 were under a moss-covered, overhanging rock on a shaded, wet hillside. Rare or absent in all other, drier habitats. Adults were reared from larvae from mosses growing on cliff at Hole-in-the-Rock, 12 miles south of Lawrence.

Previously known range: Newfoundland and Rhode Island, westward to Michigan.

48. *Limonia (Dicranomyia) humidicola*
(Osten Sacken)

Br. NH. 1974; June 11-28; univoltine.

A typical stream species, generally distributed in wet, well-shaded spots along streams and in the wet, wooded ravine; usually found in shaded niches where *Dolichopeza* was common.

Previously known range: British Columbia to Nova Scotia, southward to California, Central America and northern Georgia.

49. *Limonia (Dicranomyia) immodestoides*
Alexander

Br. 1974-1975; May 6-June 25, and August 31-September 12; bivoltine.

Rare and local; the few records were from hillside woods with luxuriant under-

growth. Absent from better drained woodlands.

Previously known range: Oregon to Newfoundland, southward to Indiana.

50. *Limonia (Dicranomyia) liberta*
(Osten Sacken)

Br. NH. 1974-1975; May 1-June 20; univoltine.

Common in vernal seepage in bottomland woods and in the mesic thicket around the margin of the pond in the NH. Rare to absent on the slopes.

Previously known range: Manitoba to Newfoundland, southward to Oklahoma and Florida, and in Bermuda.

51. *Limonia (Dicranomyia) pudica*
(Osten Sacken)

Br. NH. 1974-1975; April 29-May 31; univoltine.

Common in spring, generally distributed in bottomland woods where the understory is luxuriant, less common in poorly drained woodland.

Previously known range: Michigan to Maine, southward to Illinois and North Carolina.

52. *Limonia (Rhipidia) bryanti* (Johnson)
NH. 1974; June 17.

Rare, only one male taken beneath a protruding rock by one of the brooks which feed into the pond.

Previously known range: Colorado to Maine, southward to Arizona and Florida.

53. *Limonia (Rhipidia) domestica*
(Osten Sacken)

Br. NH. 1974-1975; May 8-July 16 and September 5-October 10; bivoltine.

Abundant and generally distributed in moist creek-margin thickets, beneath shaded banks of ravines, in flood plain woods and near seepages and the swamp; a few spread into drier, upland woods.

Previously known range: Kansas and

Iowa to New Jersey, southward to Texas and Florida; also in the neotropical region.

54. *Limonia (Rhipidia) lecontei* Alexander
NH. 1974; May 19.

One male taken from a decayed, partially submerged log in the brook just below the dam in the NH.

Previously known range: Alaska to Newfoundland, southward to California, and Virginia; also recorded from Eurasia.

55. *Limonia (Geranomyia) communis*
(Osten Sacken)

Br. NH. 1974-1975; April 16-June 26 and September 20; bivoltine.

Common and local in the continuously-wet to slightly-submerged layer of algae in the stream bed and the submerged film of algae on the margin of the stream where the water is quiet. Adults of both sexes occurred along the brook, and females were observed ovipositing on algae-covered rocks in the brook at NH.

Previously known range: Ontario westward to Washington and California, southward to Florida. This species has frequently been confused with *L. (G.) canadensis* in the literature, as noted by Alexander (1965:49).

56. *Helius (Helius) flavipes* (Macquart)

Br. NH. 1974-1975; May 8-July 16 with a single record for September 14; bivoltine.

Rare, only six specimens, from near the swamp and from bottomland woods. Adults usually rest on tall herbs.

Previously known range: Alberta to Nova Scotia, southward to Texas and Florida.

57. *Dicranoptycha elsa* Alexander

Br. NH. 1974-1975; May 22-June 3; univoltine.

Numerous in the same situations where *D. megaphallus* was found. Adults were mostly from shrubs such as buckbrush,

less commonly from poison ivy and other herbs.

Previously known range: New York to North Carolina.

58. *Dicranoptycha megaphallus* Alexander

Br. NH. 1974-1975; May 23-June 17; univoltine.

This is the most common species of its genus in the two study areas; characteristic of oak-hickory and spreading into nearby habitats. As in all species of the genus, the adults at rest stand upright, high on the tarsi, with body elevated above the upper surfaces of leaves, with the wings folded over the back.

Previously known range: North Carolina, South Carolina, and Florida.

59. *Dicranoptycha pallida* Alexander

NH. 1974-1975; June 24-July 16; univoltine.

Rare and apparently very local; all records are from swamp and low oak-hickory ecotones, where dense thickets are formed, with rich undergrowth.

Previously known range: Kansas, Indiana.

60. *Dicranoptycha septentrionis* Alexander

Br. 1974-1975; July 16-September 7; univoltine.

Numerous in flood plain woods, from patches of nettles and jewelweed, less common in open woods on hillside slopes.

Previously known range: Michigan to Massachusetts, southward to Indiana and North Carolina.

61. *Dicranoptycha sobrina* Osten Sacken

Br. NH. 1974-1975; June 10-17; univoltine.

Rare; three specimens were swept from a rather dry, open, hillside woods, where the undergrowth was largely tick trefoil (*Desmodium*).

Previously known range: Indiana to

New Jersey, southward to Tennessee and Florida.

62. *Dicranoptycha tigrina* Alexander

Br. 1974; August 31-September 21; univoltine.

Rare; and rather local, all records being from grassy patches along Coal Creek, the flies usually found in the places where *D. septentrionis* is common.

Previously known range: Indiana, Illinois, Tennessee, and North Carolina.

63. *Epiphragma fasciapennis* (Say)

Br. NH. 1974-1975; May 12-June 28; univoltine.

Common in the latter half of May and early June, and rather generally distributed in bottomland woods, in the swamp, and in dense thickets between the swamp and low oak-hickory; adults usually found on forest litter or low shrubs, less than two feet above ground.

Previously known range: Alberta to Newfoundland, southward to Louisiana and Florida.

64. *Epiphragma solatrix* (Osten Sacken)

Br. NH. 1974-1975; May 14-June 10 and July 15-September 14; bivoltine.

Common in the margins of the swamp and in bottomland forests, spreading into moist thickets nearby. Larvae were taken in April, 1974, from both wet, submerged wood in a brook and a decayed log on the forest floor. Adults emerged on May 2, 1974.

Flies of the summer generation have a smaller body size than those of the spring generation.

Previously known range: Missouri to New York, southward to Louisiana and Florida.

65. *Pseudolimnophila contempta*
(Osten Sacken)

Br. 1974-1975; May 24-June 3, and Au-

gust 3-September 21; bivoltine.

Rare, all specimens from the vicinity of shaded, hillside seepage areas. Adults were found resting on the ground rather than on plants.

Previously known range: Michigan to Newfoundland, southward to Missouri and Florida.

66. *Pseudolimnophila luteipennis*
(Osten Sacken)

Br. NH. 1971-1975; June 1-25, and August 17-September 21; bivoltine.

Numerous in the grassy edges of the swamp at NH. and in grassy patches along Coal Creek, spreading onto lower, more densely shaded hillsides. Adults were found on the wet ground rather than on plants.

Previously known range: Quebec westward to California and southward to Louisiana and Florida.

67. *Pilaria imbecilla* (Osten Sacken)

NH. 1974-1975; May 15-June 19; univoltine.

Locally common at margins of the pond, rarely spreading into nearby thickets. Adults usually rest on leaves of shrubs and taller herbage.

Previously known range: Illinois to Quebec and Massachusetts, southward to Tennessee and Georgia.

68. *Pilaria quadrata* (Osten Sacken)

NH. 1974-1975; April 29-June 19; univoltine.

Fairly common, but local, in the vicinity of the pond; adults found in great numbers on May 3, 1975, on the muddy edges of the pond, on *Polygonum hydropiper* that grows around the pond, less common in the wet thickets nearby.

Previously known range: Iowa to Nova Scotia, southward to Florida.

69. *Pilaria tenuipes* (Say)

Br. NH. 1974-1975; May 3-July 16; univoltine.

The most common species of its genus; common and generally distributed in wet thickets around the swamp and along creeks, also common in the flood plain forests, rare in mesic hillside woods. Adults were found usually standing on leaves of taller shrubs, with wings folded over the back and an elevated stance resembling that of *Dicranoptycha*.

In localities where all three species of *Pilaria* were found, *quadrata* occurred in the wettest microhabitats, *tenuipes* in the less mesic habitat, while *imbecilla* was found in between.

Previously known range: Wisconsin to New Brunswick, southward to Kansas, Texas, and Florida.

70. *Atarba (Atarba) picticornis*

Osten Sacken

Br. NH. 1974-1975; May 22-July 2, and a single record on September 21; bivoltine.

Numerous in grassy areas along the overflow channel around the dam in NH., in nettle-jewelweed patches along Coal Creek, and rare in mesic thickets and hillside habitats.

Previously known range: Michigan to New Hampshire, southward to Missouri and Florida.

71. *Elephantomyia (Elephantomyia)*

westwoodi Osten Sacken

Br. NH. 1974-1975; June 2-July 23; univoltine.

Rare, only five specimens taken, all from low, oak-hickory slopes. Adults were found hanging from leaves on low branches of trees.

Previously known range: Wisconsin to Newfoundland, southward to Illinois and Florida.

72. *Cladura (Cladura) flavoferruginea*

Osten Sacken

Br. NH. 1974-1975; October 2-21; univoltine.

This species emerges in the dry autumn and is the last tipulid species that occurs in these areas, except for the winter species *Chionea stoneana*. Adults common and generally distributed in most of the woods.

Previously known range: Wisconsin to Quebec and Maine, southward to Missouri and Georgia.

73. *Chionea stoneana* Alexander

Br. 1973; January 20. The only nearly apterous crane fly in the local fauna; univoltine.

G. W. Byers collected one live male in a pitfall trap, set by an old rubbish dump that had numerous mouse burrows beneath slabs of wood, etc. At other places, he has found *C. stoneana* in burrows and nests of mice.

Previously known range: Illinois.

74. *Teucholabis (Teucholabis) complexa*

Osten Sacken

NH. 1974; June 5.

Two specimens taken from near a vernal, seepage area, both resting on leaf litter.

Previously known range: Michigan to Connecticut, southward to Oklahoma and Florida.

75. *Teucholabis (Teucholabis) lucida*

Alexander

Br. NH. 1974-1975; May 31-June 17 and August 17-October 2; bivoltine.

Common and local in swampwoods in early summer when the water level of the pond began to drop and small bodies of water were ponded by tree roots and forest litter. Adults were resting on saturated soil around this water. Also recorded from the shaded bank of the ravine at Br.

Previously known range: Missouri to

District of Columbia, southward to Florida.

76. *Gnophomyia tristissima* Osten Sacken

Br. NH. 1974-1975; May 7-July 16; univoltine.

Common in bottomland woods and wet thickets on herbage among fallen, decaying trees.

Previously known range: Northwest Territories to Quebec and Maine, southward to Texas and Florida.

77. *Gonomyia (Gonomyia) florens*

Alexander

NH. 1974; June 24.

One male only, from the grassy margin of a brook at NH.

Previously known range: Michigan to Quebec and Maine, southward to Illinois, Tennessee, and North Carolina.

78. *Gonomyia (Gonomyia) kansensis*

Alexander

NH. 1956; May 28.

This record based on a light trap collection made by G. W. Byers in 1956.

Previously known range: Oklahoma, Missouri, Illinois, Indiana, and Michigan.

79. *Gonomyia (Gonomyia) subcinerea*

Osten Sacken

Br. NH. 1974-1975; May 8-June 16 and August 3-October 10; bivoltine.

This is the most abundant species of its genus; common and generally distributed in oak-hickory and mesic bottomland woods.

Previously known range: British Columbia to Newfoundland, southward to Utah, Kansas, and Florida.

80. *Gonomyia (Lipophleps) manca*

(Osten Sacken)

Br. 1974-1975; June 2-August 17; univoltine.

Rare, a total of twelve specimens taken in bottomland woods, mainly from grassy margins of Coal Creek.

Previously known range: Indiana to Massachusetts, southward to Tennessee, and Florida.

81. *Gonomyia (Lipophleps) sulphurella*

Osten Sacken

Br. 1974-1975; September 5-13; univoltine.

Rare, only two males taken from the same wooded ravine at Br.

Previously known range: Kansas to Newfoundland, southward to Texas and Florida.

82. *Erioptera (Symplecta) cana* (Walker)

Br. NH. 1974-1975; March 21-May 30 and September 21-29; multivoltine.

The first species to appear in the spring, when most vegetation has not yet started growing; abundant in the spring in nearly all wooded habitats and open grasslands. The fall generation was inconspicuous.

Previously known range: Alaska, throughout southern Canada and the United States.

83. *Erioptera (Erioptera) septemtrionis*

Osten Sacken

Br. 1975; April 17.

One female from a juniper tree growing at the ecotone between woods and grassy field.

Previously known range: Washington to Newfoundland, southward to California, Kansas, and Florida.

84. *Erioptera (Erioptera) vespertina*

Osten Sacken

Br. NH. 1975; May 7-22; univoltine.

Numerous; all but two were from the Malaise traps, those two swept from grassy patches near the traps.

Previously known range: Iowa to Nova Scotia, southward to Alabama and Florida.

85. *Erioptera (Mesocyphona) caliptera*
(Say)

Br. NH. 1974-1975; May 7-June 24 and July 16-August 21; bivoltine.

Abundant where soil is wet or muddy during most of the year, in bottomland forests, swampwoods, and grassy margins of streams; not spreading into the drier oak-hickory woods, but may spread to mesic hillside woods.

Previously known range: California to Newfoundland, southward to Florida; also Neotropical.

86. *Erioptera (Mesocyphona) needhami*
Alexander

Br. 1974-1975; May 31-June 11 and August 3-17; bivoltine.

Rare, only four specimens swept from grassy areas along the sandy creek shore, and two from a shaded bank of Coal Creek.

Previously known range: Missouri to Nova Scotia, southward to Florida.

87. *Erioptera (Mesocyphona) parva*
Osten Sacken

NH. 1975; July 24.

One male specimen taken from a grassy area in the swamp woods.

Previously known range: Kansas to Michigan and Connecticut, southward to Florida.

88. *Erioptera (Hoplolabis) armata*
Osten Sacken

Br. NH. 1974-1975; April 19-June 14 and July 25-August 17; bivoltine.

Abundant: adults taken along all water courses, either from shaded banks or from the base and roots of large trees growing by creeks. Large swarms seen on April 28, 1975, along Coal Creek, about five feet above ground.

Conspicuous, bimodal variation was found in the dististyles of local males, sug-

gesting that two species might have been represented.

Previously known range: Colorado to Newfoundland, southward to Oklahoma and Georgia.

89. *Erioptera (Psiloconopa) graphica*
Osten Sacken

NH. 1974-1975; April 22-June 26 and September 29; bivoltine.

Numerous and local about the margins of the pond, less numerous in the swamp woods and rare elsewhere, all individuals on herbaceous plants.

Previously known range: Nebraska to Ontario and Massachusetts, southward to Louisiana and Florida.

90. *Ormosia arcuata* (Doane)

Br. 1975; April 28.

One female recorded from the grassy margin of Coal Creek.

Previously known range: Alberta to New Brunswick, southward to Tennessee.

91. *Ormosia ingloria* Alexander

Br. 1975; September 7-13; univoltine.

Rare; all specimens collected were males, most found resting on tree trunks growing in bottomland and on hillsides. One was taken from a tall shrub.

Previously known range: Indiana and Ontario.

92. *Ormosia romanovichiana*
(Osten Sacken)

Br. 1975; April 19-28; univoltine, in early spring.

Common in spring along the creek and around most vernal seepages, usually resting on wet, moss-covered rocks or on tree bark, where *Erioptera (H.) armata* was also common. These two species can be easily differentiated in the field by the way they rest on the substrate. This species holds its body parallel to the substrate, while *E. armata* always tilts its body, head

downward, to form an angle with the substrate.

Previously known range: Illinois to Maine, southward to Tennessee and South Carolina.

93. *Tasiocera (Dasymolophilus) ursina*
(Osten Sacken)

Br. NH. 1975; May 6-14; univoltine.

Locally abundant near seepage areas and shaded brooks. On May 7 at 10 a.m. I took about forty males from swarms about two feet above ground along brooks leading to the pond at the NH. One mating pair was found at that time. All other females were from the Malaise trap at the NH.

Previously known range: Newfoundland, southward to Tennessee and North Carolina.

94. *Molophilus hirtipennis* (Osten Sacken)

NH. 1974-1975; May 15-June 13; univoltine.

Rare; only three females were taken from grassy patches in the swamp woods.

Previously known range: Ontario to Newfoundland, southward to Illinois, Tennessee, and North Carolina.

95. *Molophilus pubipennis* (Osten Sacken)

Br. NH. 1974-1975; May 6-June 11; univoltine.

Common to abundant in damp to wet, flood plain forests, and on damp, coarse, sand bars in the bed of Coal Creek. All specimens were females. Rogers (1942) believed that this species as well as *M. hirtipennis* is chiefly or entirely parthenogenetic.

Previously known range: Michigan to Quebec and Newfoundland, southward to Florida.

DISCUSSION

Crane flies occupy many types of habitats in their immature and adult stages.

The larval habitat of most species is local and restricted. Certain species live in mud, some in decaying, vegetable detritus, while others occur in rotting wood. Many larvae are scavengers, others are herbivores and still others are predaceous. In most cases, the presence or absence of a suitable, larval habitat determines whether a species can maintain itself in a given area.

During this two-year investigation, 95 species of crane flies were recorded from the two study areas, of which 56 species were common to both areas. Another 21 species were found only at the Breidenthal Reserve, the remaining 18 species only at the Natural History Reservation. Other species and subspecies recorded from northeastern Kansas, but not taken in either of the study areas are: *Dolichopeza (Oropeza) polita pratti*, *Tipula (Schumelia) hermannia*, *T. (Nippotipula) abdominalis*, *T. (Beringotipula) borealis*, *T. (Lunatipula) incisa kansensis*, *Limonia (Geranomyia) rostrata*, *Dicranoptycha minima*, *Erioptera (Psiloconopa) armillaris*, and *E. (P.) venusta*.

The crane-fly fauna of eastern Kansas is relatively poor when contrasted with the faunas of the eastern states: New England (Johnson, 1925, and Alexander, 1925, 1927, 1930, 1936) has 337 species; New York (Alexander, 1919, 1922, 1924, 1929), 318 species; southeastern Michigan (Rogers, 1942), 201 species. This can be explained largely by the geographical location of Kansas. Eastern Kansas is located in a transition zone between the eastern forests and the central plains. The prairie forms a natural barrier, preventing the eastward spread of western species. Consequently, there is an abrupt difference in crane fly fauna between eastern Kansas and mountainous central Colorado. Most Kansas crane flies are eastern species, occurring also in forests and other appropriate habitats eastward to the Atlantic Ocean. Since crane flies are more abun-

dant in moist woodlands, the relatively small number of tipulid species in eastern Kansas is probably due to the decline of forests from east to west.

Climate also affects the distribution of crane flies. The subfamily Limoniinae is more abundantly represented in the humid eastern forests and decreases westward, as average humidity gradually drops. In terms of percentage of the total crane fly fauna, the situation is reversed for the subfamily Tipulinae. This can be seen by comparing the percentage of Tipulinae in New England—34% of 337 species (Johnson, 1925, Alexander, 1925, 1927, 1930, 1936), in New York—29% of 318 (Alexander, 1919, 1922, 1924, 1929), in Tennessee—30% of 151 (Rogers, 1930), in Ohio—34% of 146 (Foote, 1956), in Michigan—36% of 201 (Rogers, 1942), and in eastern Kansas—39% of 95. The significance of the increasing percentage of Tipulinae can be shown by use of the chi-square test (Snedecor, 1956). It is noteworthy that no species of the large genus *Limnophila* have been found in eastern Kansas. *Limnophila* comprises 14% of the crane fly fauna in New England, 17% in New York, 9% in Tennessee, 8% in Ohio, 9% in Michigan. Most other aquatic, predaceous genera such as *Hexatoma* and *Pedicia* are also absent from Kansas. The absence in Kansas of marshes, bogs, and other permanently wet habitats, other than artificial ponds (all of relatively recent origin) and a few major streams, usually very muddy, probably accounts for the absence of these genera.

The differences in distribution of species in the two study areas are due more to topographic than to climatic conditions, since there is no significant difference in climatic conditions between the two areas. The general floras of the two areas are obviously quite different, although there are many species common to both. Since the Natural History Reservation was not established until thirty years ago, its vege-

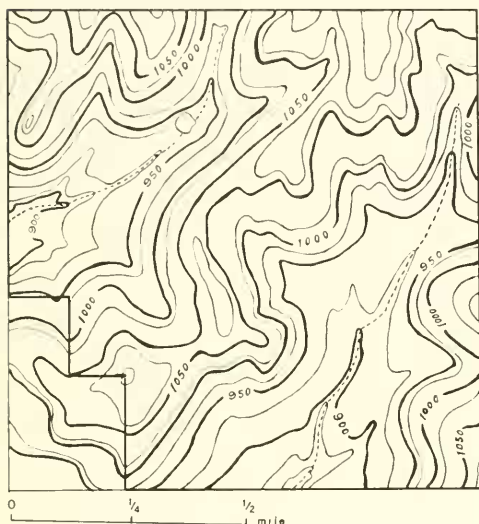
tation is still in a successional state, in which climax oaks and hickories do not yet dominate much of the area. In the Breidenthal Reserve, the vegetation has reached a stable, climax state.

The two areas differ in humidity and water drainage. Within the Breidenthal Reserve, Coal Creek is a well-developed stream, supplied by numerous, short tributaries, so that it flows during most of the year. The slopes around the creek are relatively steep. The hillsides immediately bordering the creek rise 200 feet in less than a quarter of a mile. Apparently much of the rain that falls on the high land surrounding the Coal Creek ravine at first becomes groundwater, but later seeps through the steep hillsides to feed moisture into the ravine. Three additional factors contribute to retention of moisture in the Coal Creek ravine. A large proportion of the vegetation at the Breidenthal Reserve has reached the climax stage and retains moisture well. The ravine opens toward the northeast and its outlet is greatly restricted by ridges which make it an enclosed basin, as a result of which it is protected from the southwestern summer winds of eastern Kansas. Finally, there are many relatively steep, north-facing slopes at the Breidenthal Reserve, resulting in shade and, consequently, less evaporation. The total result is higher humidity at the Breidenthal Reserve than at the Natural History Reservation.

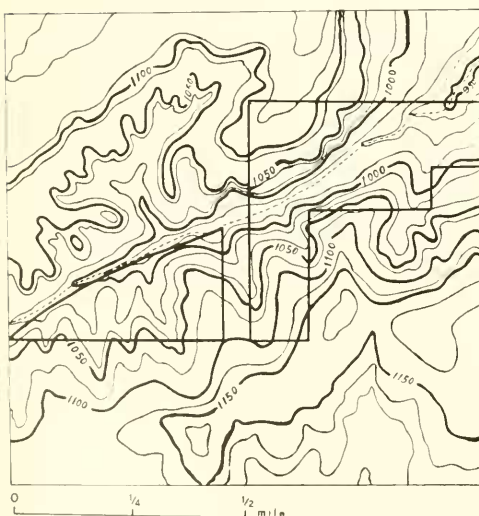
On the Natural History Reservation the streams are small and intermittent, being near their headwaters. They dry out shortly after the beginning of summer. While the total relief is comparable to that of the Breidenthal Reserve, the slopes are generally not as steep, and many of the streams follow ravines which open directly to the southwest and so are exposed to the drying effects of summer winds. Furthermore, much of the vegetation at the Nat-

ural History Reservation is still successional and holds less moisture.

The investigation made to determine ecological differences between the two reservations that would result in the mutually exclusive distribution of the 39 species was narrowed to 7 species, due to the fact that



TEXT FIGURE 1. Contour map of the Natural History Reservation.



TEXT FIGURE 2. Contour map of the Breidenthal Reserve.

the other 32 were collected only infrequently. The presence at the Natural History Reservation of the artificial pond with its muddy-shore habitat probably accounts for the presence there of *Tipula* (Y.) *tricolor*, *Pilaria imbecilla*, *P. quadrata*, and *Teucholabis complex*, which were found only there. No such habitat exists at the Breidenthal Reserve. The small, rapid streams with algae- or moss-covered rocks in and along them may explain why *Limonia* (R.) *bryanti* and *L. (R.) lecontei* were found only at the Natural History Reservation. This type of habitat probably also accounts for the fact that *L. (G.) communis* is abundant in the Natural History Reservation but rare in the Breidenthal Reserve.

The emergence of adult flies is influenced mostly by local climate. Warm, humid weather in early spring brings vernal species out earlier, while a hot, dry summer delays appearance of autumnal species. As compared to the seasonal distribution of crane flies in southern Michigan, the eastern Kansas population comes out earlier in the spring and disappears later in autumn, due to the longer duration from the last, spring, killing frost to the first, autumnal, killing frost. Several species that have but a single adult season in southern Michigan have two distinct ones in eastern Kansas.

From the preceding study it seems reasonable to draw three conclusions. First, crane flies of eastern Kansas had their origins in the eastern part of the continent. Second, geographical and climatic factors have differentiated the crane fly faunas of eastern Kansas and the more eastern states. Third, mainly topographic and historical factors have influenced the differences in crane fly faunas between the Breidenthal Reserve and the Natural History Reservation.

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APPENDIX

A KEY TO THE ADULT CRANE FLIES
OF EASTERN KANSAS

(modified from Alexander, 1942)

1. Terminal segment of maxillary palpus elongate; antennae usually with 13 segments; wings with Sc₁ usually atrophied; body size large (Fig. 1) (Tipulinae) 2
- Terminal segment of maxillary palpus short; antennae usually

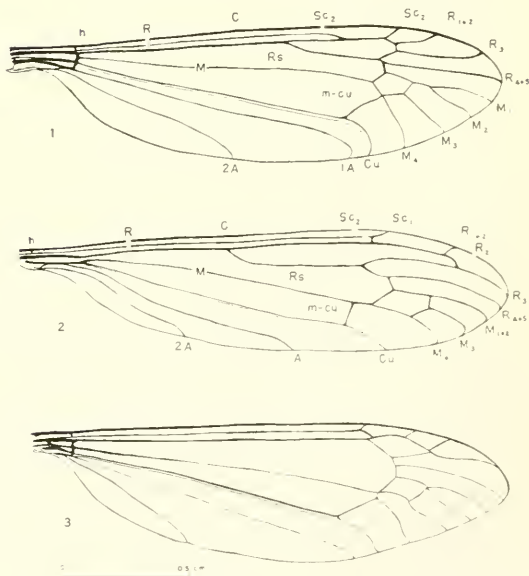


FIG. 1. Wing of *Tipula* (*Lunatipula*) *flaroumbrosa*; A—anal veins, C—costa, Cu—cubitus, M—media, m-cu—median-cubital cross-vein, R—radius, Rs—radial sector, Sc—subcosta. FIG. 2. Wing of *Limonia* (*Limonia*) *cinctipes*. FIG. 3. Wing of *Nephrotoma* *eucerooides*.

- with 14 or 16 segments; wings with Sc_1 present; body size small or medium (Fig. 2) (Limoniinae) 41
2. Legs long and filiform, tarsi as long as femur and tibia together; wings with vein R_{1+2} atrophied (Dolichocheza) 3
 Legs of normal stoutness; wings with vein R_{1+2} present 6
3. Gonapophyses with tips flattened, the apex irregularly toothed (Fig. 4) *Dolichocheza walleyi*
 Gonapophyses shaped like small knobs, bearing decurved stout black spines and bristles (Fig. 5) 4
4. Tergal arms (9th abdominal tergum) widely flared and emarginate at tips; teeth of ninth tergum not set close together (Fig. 6) *Dolichocheza obscura*
 Tergal arms not flared or emarginate at tips; teeth of ninth tergum set close together on common base 5
5. Three teeth of ninth tergum of nearly equal length (Fig. 7) *Dolichocheza tridenticulata*
 Three teeth of ninth tergum with middle tooth the longest (Fig. 8) *Dolichocheza polita pratti*
6. Wings with R_s shorter than m-cu; thoracic dorsum, less often other body surfaces; highly polished (Fig. 3) (*Nephrotoma*) 7
 Wings with R_s elongate, exceeding m-cu, body surfaces pruinose or pollinose (*Tipula*) 13
7. Thoracic stripes black 8
 Thoracic stripes not black 9
8. Occiput dull; wing-tip clear *Nephrotoma virescens*
 Occiput with a polished triangular brand; wing-tip darkened *Nephrotoma alterna*
9. Mesonotum dull *Nephrotoma macrocera*
 Mesonotum polished 10
10. Flagellar segments unicolorous *Nephrotoma ferruginea*
 Flagellar segments bicolorous 11
11. Stigma dark brown, wing-tips distinctly darkened *Nephrotoma polymera*
 Stigma yellowish brown, wing-tips not darkened 12
12. Antennae (male) 19-segmented *Nephrotoma eucera*
 Antennae (male) 17-segmented *Nephrotoma euceroidea*
13. Outer cells of wings with macrotrichia (subgenus *Trichotipula*) 14
 Cells of wings without macrotrichia 15
14. Body color bright polished yellow, reddish and black; antennae short; macrotrichia of cells restricted to cells R_5 and M_1 *Tipula stonei*
 Body color dull brown and yellow; antennae of male elongate; macrotrichia in cells R_3 to 2nd M_2 *Tipula unimaculata*
15. R_s long, fully twice m-cu; m-cu uniting with M_{3+4} some distance before fork of latter (subgenus *Nippotipula*) *Tipula abdominalis*
 Wings with m-cu inserted at the fork of M_{3+4} or beyond, on base of M_1 16
16. Wings with m-cu long, so that cell M_4 is very deep, much wider at base than at margin (subgenus *Schummelia*) *Tipula hermannia*
 Wings with m-cu of moderate length, cell M_4 only a little wider at base than at margin 17



FIG. 4. Gonapophyses of *Dolichopeza (Oropeza) walleyi*, dorsal aspect. FIG. 5. Gonapophyses of *D. (O.) obscura*, dorsal aspect. FIG. 6. Ninth tergum of male *D. (O.) obscura*. FIG. 7. Ninth tergum of male *D. (O.) tridenticulata*. FIG. 8. Ninth tergum of male *D. (O.) polita pratti*. FIG. 9. Squama of *Tipula (L.) duplex*.

17. Male hypopygium with ninth tergum and sternum fused into a continuous ring (Fig. 10) 18
- Male hypopygium with the ninth tergum and sternum separated by pale membrane (Fig. 11) 23
18. Wings usually patterned with longitudinal bands, mainly along veins; ninth abdominal tergum of male produced backward as median lobe or pair of lobes bearing small black denticles (Fig. 12) (subgenus *Yamatotipula*) 19
- Wings not patterned with longitudinal bands; ninth abdominal tergum of male shallowly emarginate medially (Fig. 13) (subgenus *Platytipula*) 20
19. Wings unmarked except for stigmal darkening and dark costal

border; no dark seam on vein Cu and m-cu *Tipula sayi*
Wings longitudinally striped with brown and white; a dark seam on vein Cu and m-cu 20

20. Wings with the cells beyond cord, including R_5 , darkened *Tipula tricolor*
Wings with outer portion of cell R_5 white 21
21. Wings with vein 2A bordered by brown *Tipula furca*
Wings with vein 2A not bordered by brown *Tipula strepens*
22. Wings patterned with brown areas in cell M and at outer end of vein 2A *Tipula ultima*
Wings without brown areas; costal border of wings dark brown (Fig. 14) *Tipula paterifera*
23. Squama naked 24
Squama with a small group of setae (Fig. 9) (subgenus *Lunatipula*) 26
24. Male hypopygium elongated, cylindrical, upturned at an angle to remainder of abdomen (subgenus *Beringotipula*) *Tipula borealis*
Male hypopygium not elongated, not upturned at an angle to remainder of abdomen (subgenus *Pterelachisus*) 25
25. Wing pattern pale; basal section of M_{3+4} shorter than basal section of M_{1+2} *Tipula ignobilis*
Wing pattern heavy; basal section of M_{3+4} subequal to basal section of M_{1+2} *Tipula trivittata*
26. Wings with cell 1st M_2 very small, second section of M_{1+2} shorter than or subequal to petiole of cell M_1 27

- Wings with cell 1st M_2 normally elongated, second section of M_{1+2} exceeding petiole of cell M_1 28
27. Second section of M_{1+2} shorter than petiole of cell M_1
..... *Tipula bicornis*
Second section of M_{1+2} subequal to petiole of cell M_1
..... *Tipula morrisoni*
28. Male hypopygium asymmetrical, right basistyle produced caudad into a conspicuous 2-branched arm (Fig. 20) *Tipula fuliginosa*
Male hypopygium symmetrical 29
29. Cells beyond cord of wing darkened 30
Cells beyond cord of wing uniformly colored 31
30. Cells basad of cord strongly infumed *Tipula dorsimacula*
Cells basad of cord uniformly pale in color *Tipula mallochii*
31. Antennae with bases of flagellar segments light yellow, the remainder black *Tipula flavibasis*
Antennae with flagellum, if bicolorous, with bases of segments darker than remainder 32
32. Antennae (male) elongate, if bent backward extending about to fourth abdominal segment
..... *Tipula disjuncta*
Antennae (male) shorter, not extending caudad beyond base of abdomen 33
33. Male hypopygium with caudal margin of ninth tergum having two rounded emarginations, one on either side of double median spinous point; eighth sternum with sclerotized teeth (Fig. 16) 34
Male hypopygium without two rounded emarginations on caudal margin of ninth tergum, eighth sternum without sclerotized teeth 37
34. Male hypopygium with median tergal spines long and slender, needle-like (Fig. 16) 35
Male hypopygium with median tergal spines short (Fig. 15) 36
35. Submedian teeth of eighth sternum slender, parallel-side (Fig. 25) *Tipula triplex*
Submedian teeth of eighth sternum broad at base, with narrow,

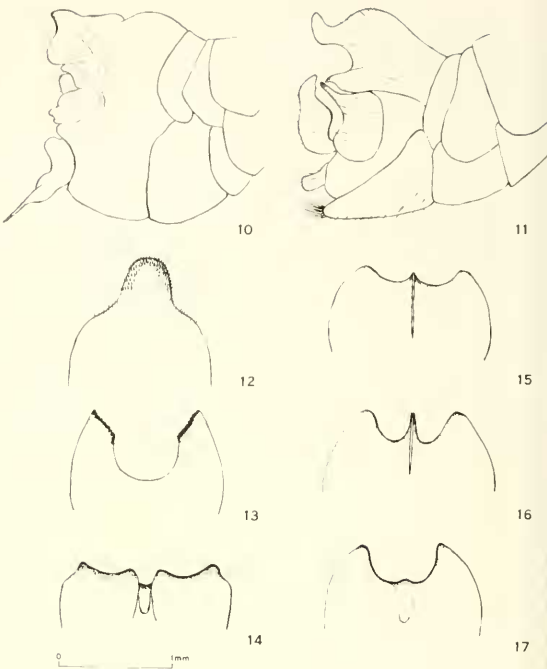


FIG. 10. Ninth segment of male *Tipula* (*Platytipula*) *ultima*, lateral aspect. FIG. 11. Ninth segment of male *Tipula* (*Lunatipula*) *bicornis*, lateral aspect. FIG. 12. Ninth tergum of male *T. (Yamatotipula) furca*, dorsal aspect. FIG. 13. Ninth tergum of male *T. (P.) ultima*, dorsal aspect. FIG. 14. Ninth tergum of male *T. (P.) paterifera*, dorsal aspect. FIG. 15. Ninth tergum of *T. (L.) flavovimbrosa*, dorsal aspect. FIG. 16. Ninth tergum of male *T. (L.) triplex*, dorsal aspect. FIG. 17. Ninth tergum of male *T. (L.) dietziana*, dorsal aspect.

- rounded apex (Fig. 26)
 *Tipula integra*
36. Submedian teeth of eighth sternum triangular in outline, broad basally, narrowed apically (Fig. 27) *Tipula flavoumbrosa*
 Eighth sternum having a median depressed lobe arising upside down and slightly cephalad of the submedian teeth (Fig. 28)
 *Tipula perlongipes*
37. Ground color of mesonotum gray or grayish, pleura light gray 38
 Ground color of mesonotum brownish or yellow, pleura yellowish 39
38. Male hypopygium with eighth sternum armed with four conspicuous lobes (Fig. 24)
 *Tipula australis*
 Male hypopygium with eighth sternum bilobed (Fig. 19)
 *Tipula dietziana*
39. Male hypopygium with lateral lobes of ninth tergum produced into long curved horns (Fig. 18) ..
 *Tipula tuscatorora*
 Male hypopygium without curved tergal horns (Fig. 23) 40
40. Outer appendage of inner dististyle elongate, terminating in an acute spine (Fig. 21) .. *Tipula duplex*
 Outer appendage of inner dististyle elongate but broad at apex (Fig. 22) *Tipula translucida*
41. Free tip of Sc_2 often present; veins R_4 and R_5 fused to margin, only two branches of Rs being present; antennae usually with 14 or 16 segments (Fig. 2) (*Limoniini*) 42
 Free tip of Sc_2 atrophied; veins R_4 and R_5 separate, with three branches of Rs present (exceptions in *Atarba*, *Elephantomyia*, *Teucholabis*); antennae usually 16 segments (Fig. 41) 68
42. Wings with vein R_2 lacking
 (*Helius*) *Helius flavipes*
 Wings with vein R_2 present 43
43. Antennae 14-segmented; R_2 basal in position, opposite or not far beyond the level of r-m .. (*Limonia*) 44
 Antennae 16-segmented; R_2 far distad of level of r-m
 (*Dicranoptycha*) 62
44. A supernumerary crossvein in cell 1st A, connecting the two anal veins (subgenus *Discobola*)
 *Limonia annulata*
 No supernumerary crossvein in cell 1st A 45
45. Mouthparts and especially the labial palpi lengthened, the rostrum about as long as the combined head and thorax (Fig. 32)
 (subgenus *Geranomyia*) 46
 Mouthparts not conspicuously lengthened, shorter than the remainder of head 47
46. Wings heavily patterned with dark brown, including a series of 4 or 5 large costal areas
 *Limonia rostrata*
 Wings unmarked
 *Limonia communis*
47. Antennae of males more or less branched; of females simply serrate (Fig. 31)
 (subgenus *Rhipidia*) 48
 Antennae of both sexes simple 50
48. Wings with abundant pale brown or gray dots in all cells
 *Limonia lecontei*
 Wings with the markings larger, confined to vicinity of veins 49

49. Wings with m-cu far before fork of M; antennae with segment 12 and 13 white in color *Limonia domestica*
Wings with m-cu at fork of M; antennae dark throughout *Limonia bryanti*
50. Vein Sc shorter, ending opposite basal one-third of Rs or before (subgenus *Dicranomyia*) 51
Vein Sc long, ending opposite midlength of Rs or beyond 56
51. Wing with cell 1st M₂ open by atrophy of m *Limonia immodestoides*
Wing with cell 1st M₂ closed 52
52. Antennae entirely yellow or with basal two segments yellow; body coloration pale yellow or ochre-yellow 53
Antennae dark, brown or black, throughout; body coloration yellowish brown, gray or polished black 54
53. Male hypopygium with the rostral prolongation bifid at apex (Fig. 42) *Limonia divisa*
Male hypopygium with the rostral prolongation extended into a long blackened point (Fig. 47) *Limonia pudica*
54. Femora brown, the tips broadly yellow *Limonia humidicola*
Femora without paler tips 55
55. General coloration of thorax clear gray, male hypopygium with rostral spines originating from enlarged basal tubercles (Fig. 46) *Limonia liberta*
General coloration of thorax brown, rostral spines without basal tubercles (Fig. 43) *Limonia haeretica*

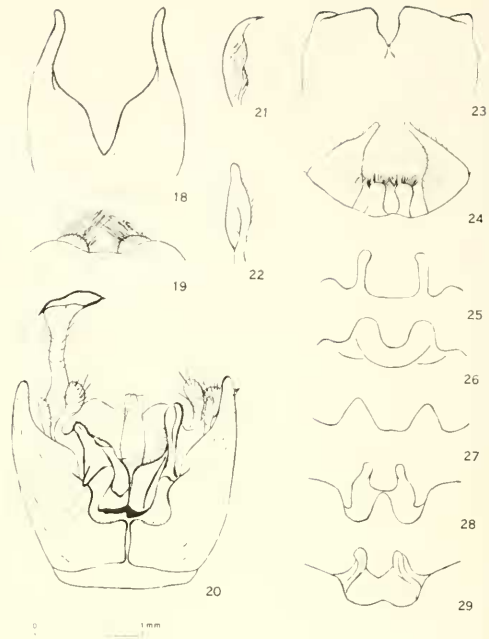


FIG. 18. Ninth tergum of male *Tipula* (*Lunatipula*) *tuscator*. FIG. 19. Eighth sternum of male *T. (L.) dietziana*. FIG. 20. Ninth tergum of male *T. (L.) fuliginosa*, dorsal aspect. FIG. 21. Right inner dististyle of male *T. (L.) duplex*, lateral aspect. FIG. 22. Right inner dististyle of male *T. (L.) translucida*, lateral aspect. FIG. 23. Ninth tergum of male *T. (L.) duplex*. FIG. 24. Eighth sternum of male *T. (L.) australis*. FIG. 25. Eighth sternum of male *T. (L.) triplex*. FIG. 26. Eighth sternum of male *T. (L.) integra*. FIG. 27. Eighth sternum of male *T. (L.) flavoumbrosa*. FIG. 28. Eighth sternum of male *T. (L.) perlongipes*. FIG. 29. Eighth sternum of male *T. (L.) triplex* group, species near *perlongipes*.

56. Vein Sc₁ and Sc₂ ending opposite the fork of Rs (subgenus *Metalimnobia*) 57
Vein Sc₁ and Sc₂ ending about opposite midlength of Rs (subgenus *Limonia*) 60
57. Wings yellow, with three subcircular, eye-like brown markings, placed at origin and fork of Rs and at stigma; femora with only one brown band at the tip *Limonia triocellata*
Wings without such an ocelliform

pattern; femora with more than one brown band 58

58. Knobs of halteres uniformly brownish black *Limonia fallax*
Knobs of halteres pale at tips 59

59. Femora with two brown rings, the outer ring narrow and subterminal in position
..... *Limonia cinctipes*

Femora with three brown rings, the outer ring nearly terminal in position *Limonia immatura*

60. Wings unmarked; free tip of Sc_2 lying markedly basad of R_2
..... *Limonia globithorax*
Wings patterned; free tip of Sc_2 and R_2 in transverse alignment 61

61. R_{1+2} and R_2 subequal in length; legs uniformly dark brown
..... *Limonia rara*
 R_{1+2} two or more times as long as R_2 ; wings with three small brown dots along costal border
..... *Limonia tristigma*

62. Fore femora extensively blackened, the bases restrictedly pale; remaining femora more narrowly blackened at tips 63
Femora at most blackened only at extreme tips 64

63. Costal fringe of wings (male) long and conspicuous
..... *Dicranoptycha sobrina*
Costal fringe of wings (male) short and dense
..... *Dicranoptycha megaphallus*

64. Tips of femora narrowly blackened or strongly infumed 65
Femora uniformly pale 66

65. Tips of femora very narrowly dark brown; abdominal terga transversely banded in tigrine

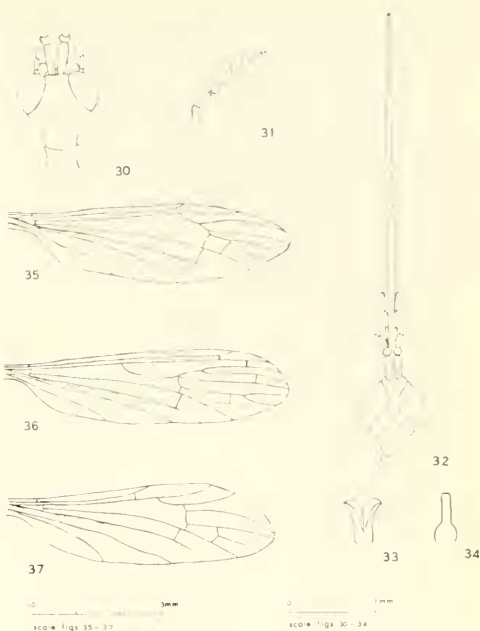


FIG. 30. Head of *Pseudolimnophila luteipennis*, dorsal aspect. FIG. 31. Antenna of *Limonia (Rhipidia) domestica*, dorsal aspect. FIG. 32. Head of *Limonia (Geranomyia) communis*, dorsal aspect. FIG. 33. Aedeagus of *Dicranoptycha elsa*, dorsal aspect. FIG. 34. Aedeagus of *D. septemtrionis*, dorsal aspect. FIG. 35. Wing of *Atarba picticornis*. FIG. 36. Wing of *Cladura flavoferruginea*. FIG. 37. Wing of *Gonomyia manca*.

color; male with long gonapophyses, bifid near tip
..... *Dicranoptycha tigrina*

Tips of femora broadly blackened; abdominal terga without subterminal dark, transverse bands; male gonapophyses not bifid at tips *Dicranoptycha minima*

66. Body coloration yellow; wing yellow *Dicranoptycha pallida*
Body coloration dark brown; wing grayish to pale brown 67

67. Male hypopygium with aedeagus bifid at apex (Fig. 33)
..... *Dicranoptycha elsa*
Male hypopygium with aedeagus simple (Fig. 34)
..... *Dicranoptycha septemtrionis*

68. Tibial spurs present
 (tribe Hexatomini) 69
 Tibial spurs lacking
 (tribe Eriopterini) 77
69. Rostrum elongate, exceeding one-half length of entire body
 (*Elephantomyia*)
 *Elephantomyia westwoodi*
 Rostrum short, not exceeding in length remainder of head 70
70. Wings with two branches of Rs reaching the margin (Fig. 35)
 (*Atarba*) *Atarba picticornis*
 Wings with three branches of Rs reaching the margin 71
71. A supernumerary crossvein in cell C
 (*Epiphragma*) 72
 No supernumerary crossvein in cell C 73
72. Wings with pale brown crossbands; a brown ring at tip of each femur *Epiphragma fasciapennis*
 Wings with an irregular pattern of brown; a brown ring before tip of each femur *Epiphragma solatrix*
73. Wings with Sc relatively short, Sc₁ ending before level of fork of Rs; antennae with long, conspicuous verticils; head not conspicuously narrowed behind
 (*Pilaria*) 74
 Wings with Sc longer, Sc₁ ending opposite or beyond level of fork of Rs; antennae verticils not conspicuously long; head strongly narrowed and prolonged behind (Fig. 30)
 (*Pseudolimnophila*) 76
74. Wings with cell M₁ absent; general coloration of thorax blackish
 *Pilaria quadrata*
 Wings with cell M₁ present 75
75. Thoracic dorsum dark brown to black; antennae of males elongate, exceeding one-half length of body *Pilaria tenuipes*
 Thoracic dorsum yellow to brownish yellow; antennae short in both sexes, not extending caudad beyond base of abdomen
 *Pilaria imbecilla*
76. Thoracic pleura pale, striped longitudinally with dark brown, wings unmarked
 *Pseudolimnophila contempta*
 Thoracic pleura uniform light to dark gray; wings marked with pale brown at stigma and along crossveins
 *Pseudolimnophila luteipennis*
77. Nearly apterous species; wings smaller than halteres
 (*Chionea*) *Chionea stoneana*
 Fully-winged species 78
78. Wings with cell M₁ present (Fig. 36)
 (*Cladura*)
 *Cladura flavoferruginea*
 Wings with cell M₁ absent (Fig. 37) 79
79. Two branches of Rs reach wing-margin 80
 Three branches of Rs reach wing-margin 82
80. Wings with Sc long, Sc₁ ending beyond origin of Rs
 (*Teucholabis*) 81
 Wings with Sc short, Sc₁ ending before origin of Rs (Fig. 37)
 *Gonomyia manca*
81. Sc long, Sc₁ ending far beyond midlength of Rs
 *Teucholabis complexa*
 Sc shorter, Sc₁ ending slightly beyond origin of Rs
 *Teucholabis lucida*

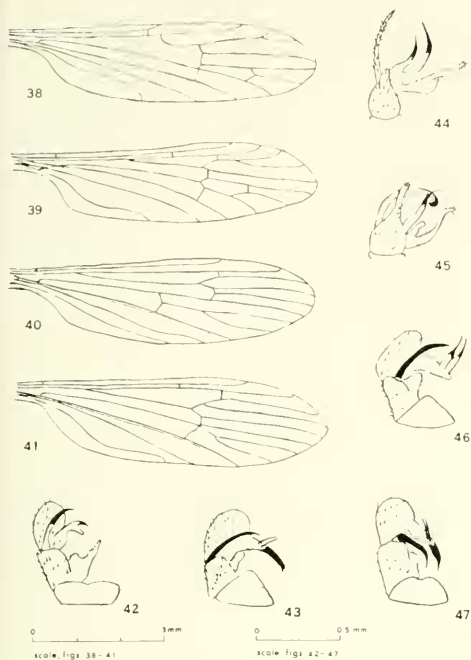


FIG. 38. Wing of *Gonomyia sulphurella*. FIG. 39. Wing of *Ormosia romanovichiana*. FIG. 40. Wing of *Molophilus pubipennis*. FIG. 41. Wing of *Erioptera (Erioptera) septemtrionis*. FIG. 42. Ventral dististyle of *Limonia (Dicranomyia) divisa*, dorsal aspect. FIG. 43. Ventral dististyle of *L. (D.) haeretica*, dorsal aspect. FIG. 44. Inner dististyle of *Gonomyia kansensis*, dorsal aspect. FIG. 45. Inner dististyle of *G. florens*, dorsal aspect. FIG. 46. Ventral dististyle of *L. (D.) liberta*, dorsal aspect. FIG. 47. Ventral dististyle of *L. (D.) pudica*, dorsal aspect

82. Wings with vein R_3 shorter than petiole of cell R_3 (*Gonomyia*) 83
 Wings with vein R_3 longer than petiole of cell R_3 86
83. Cell R_3 very small, its extent along costal margin subequal to that of cell R_2 (Fig. 38)
 *Gonomyia sulphurella*
 Cell R_3 large, its extent along costal margin much greater than that of cell R_2 84
84. Wings with cell 1st M_2 closed
 *Gonomyia subcinerea*
 Wings with cell 1st M_2 open, merged with cell M_3 85

85. Male hypopygium with inner arm of inner dististyle bifid (Fig. 44)
 *Gonomyia kansensis*
 Male hypopygium with inner arm of inner dististyle simple, undivided (Fig. 45) *Gonomyia florens*
86. Wings with distinct macrotrichia in outer cells 87
 Wings with the outer cells glabrous 90
87. Size very small (wings 2.6 mm. or less); cell R_3 sessile, without element R_{2+3+4} ; body dark brown (*Tasiocera*) *Tasiocera ursina*
 Size larger; cell R_3 petiolate by presence of R_{2+3+4} (*Ormosia*) 88
88. Wings with cell 1st M_2 open
 *Ormosia ingloria*
 Wings with cell 1st M_2 closed 89
89. Wings clouded with dark; anal veins convergent (Fig. 39)
 *Ormosia romanovichiana*
 Wings unicolorous
 *Ormosia arcuata*
90. R_s ending in cell R_3 , no element R_{2+3+4} (Fig. 40) .. (*Molophilus*) 91
 R_s ending in cell R_4 , with short vein R_{2+3+4} present 92
91. Body coloration pale reddish yellow; fore femora extensively blackened, remaining femora yellowish *Molophilus pubipennis*
 Body coloration dark brown
 *Molophilus hirtipennis*
92. Coxae of middle and hind legs only slightly separated by small meral region; knobs of halteres light yellow (*Gnophomyia*)
 *Gnophomyia tristissima*
 Coxae of middle and hind legs widely separated by large meral region (*Erioptera*) 93

93. A supernumerary crossvein in cell R₃; vein 2A strongly sinuate
 (subgenus *Symplecta*)
 *Erioptera cana*
 No supernumerary crossvein in cell R₃ 94
94. Wings with anal veins convergent, cell 1st A at midlength usually as broad as, or broader than, at margin (Fig. 41)
 (subgenus *Erioptera*) 95
 Wings with anal veins divergent, cell 1st A widest at margin 96
95. Knobs of halteres dark brown; body coloration brown
 *Erioptera septemtrionis*
 Halteres pale throughout; body coloration pale yellow
 *Erioptera vespertina*
96. Wings with cell 1st M₂ open
 (subgenus *Mesocyphona*) 97
 Wings with cell 1st M₂ closed 99
97. Wings with a faint brown tinge, the cord and veins at margin with small dark brown spots
 *Erioptera parva*
 Wings with a strong brown tinge, variegated with numerous white spots and dots 98
98. Femora with two brown rings
 *Erioptera caliptera*
 Femora with single brown ring
 *Erioptera needhami*
99. Wings with a spur from the angulated basal section of vein M₃ jutting basad into cell 1st M₂
 (subgenus *Hoplolabis*)
 *Erioptera armata*
 Wings without such a spur
 (subgenus *Psiloconopa*) 100
100. Wings with two broad brown crossbands *Erioptera venusta*
 Wings with dark pattern broken into small spots or narrow broken bands 101
101. Femora with two broad black rings *Erioptera graphica*
 Femora with two narrow brown rings *Erioptera armillaris*